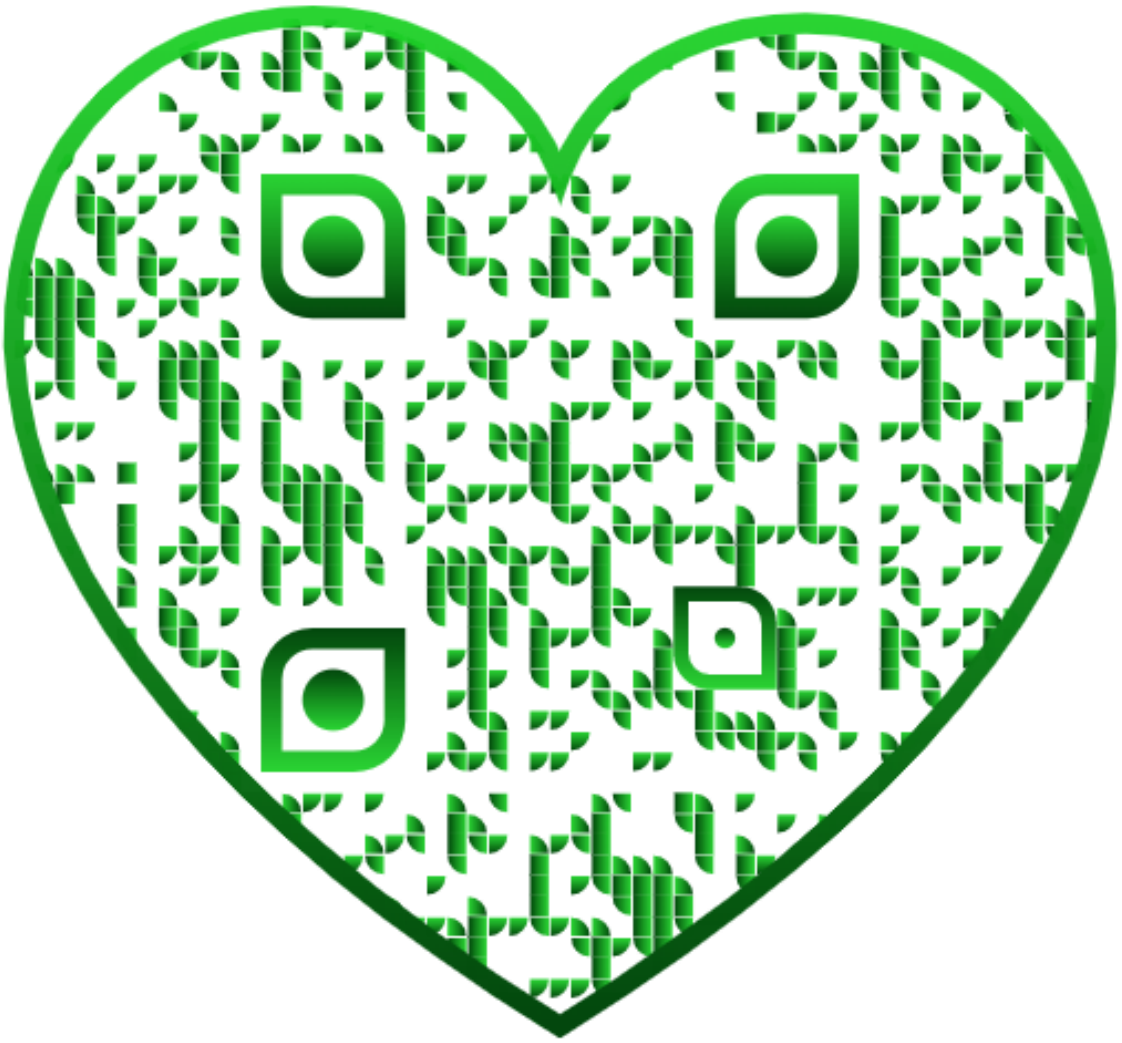
Patient Safety

World Health Organization

Medication safety for look-alike, sound-alike medicines

MEDICATION WITHOUT HARM

Global Patient Safety Challenge



Patient Safety

World Health Organization

Medication safety for look-alike, sound-alike medicines

MEDICATION WITHOUT HARM
Global Patient Safety Challenge

Medication safety for look-alike, sound-alike medicines

ISBN 978-92-4-005889-7 (electronic version)
ISBN 978-92-4-005890-3 (print version)

© *World Health Organization 2023*

Some rights reserved. This work is available under the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 IGO licence (CC BY-NC-SA 3.0 IGO; *https://creativecommons.org/licenses/by-nc-sa/3.0/igo*).

Under the terms of this licence, you may copy, redistribute and adapt the work for non-commercial purposes, provided the work is appropriately cited, as indicated below. In any use of this work, there should be no suggestion that WHO endorses any specific organization, products or services. The use of the WHO logo is not permitted. If you adapt the work, then you must license your work under the same or equivalent Creative Commons licence. If you create a translation of this work, you should add the following disclaimer along with the suggested citation: "This translation was not created by the World Health Organization (WHO). WHO is not responsible for the content or accuracy of this translation. The original English edition shall be the binding and authentic edition".

Any mediation relating to disputes arising under the licence shall be conducted in accordance with the mediation rules of the World Intellectual Property Organization (*http://www.wipo.int/amc/en/mediation/rules/*).

Suggested citation. Medication safety for look-alike, sound-alike medicines. Geneva: World Health Organization; 2023. Licence: https://creativecommons.org/licenses/by-nc-sa/3.0/igo/

Cataloguing-in-Publication (CIP) data. CIP data are available at *http://apps.who.int/iris*.

Sales, rights and licensing. To purchase WHO publications, see *http://apps.who.int/bookorders*. To submit requests for commercial use and queries on rights and licensing, see *https://www.who.int/copyright*.

Third-party materials. If you wish to reuse material from this work that is attributed to a third party, such as tables, figures or images, it is your responsibility to determine whether permission is needed for that reuse and to obtain permission from the copyright holder. The risk of claims resulting from infringement of any third-party-owned component in the work rests solely with the user.

General disclaimers. The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of WHO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by WHO in preference to others of a similar nature that are not mentioned. Errors and omissions excepted, the names of proprietary products are distinguished by initial capital letters.

All reasonable precautions have been taken by WHO to verify the information contained in this publication. However, the published material is being distributed without warranty of any kind, either expressed or implied. The responsibility for the interpretation and use of the material lies with the reader. In no event shall WHO be liable for damages arising from its use.

Photo credits: Figure 1a, 1b and Figure 2 – WHO Patient Safety Flagship

Design and layout: Macro Graphics Pvt. Ltd., India

Contents

Acknowledgements iv

Acronyms v

Executive summary 1

1. Background 3

1.1 Purpose and methods 3

1.2 Look-alike, sound-alike (LASA) errors 4

2. The problem 5

2.1 Introduction 5

2.2 Examples 5

2.3 Scale of errors 8

3. Causes and impact of LASA errors 9

3.1 Stages of medication use at which LASA errors can occur 9

3.1.1 Prescribing 9

3.1.2 Transcribing or documenting 9

3.1.3 Dispensing 9

3.1.4 Administering 10

3.1.5 Monitoring 10

3.2 Clinical impact of LASA errors and vulnerable patients 10

4. Addressing LASA errors 11

4.1 Medicines as products to be addressed 11

4.1.1 Developing and updating the list of LASA medicines 12

4.1.2 "Tall man" lettering 12

4.1.3 Clear labelling, segregating storage and colour coding 13

4.2 Roles of patients and family members in preventing LASA errors 14

4.3 Roles of health and care workers in preventing LASA errors 14

4.3.1 Training of health and care workers 14

4.3.2 Roles of regulators, naming bodies and manufacturers 15

4.4 Health care systems and practices to be addressed 15

4.5 Additional points for consideration by member states and organizations 17

5. Barriers and enablers 18

5.1 Barriers 18

5.2 Enablers 18

References 19

Annex: glossary 23

Acknowledgements

Development of this document was coordinated by Neelam Dhingra-Kumar, Unit Head, Patient Safety Flagship, World Health Organization (WHO) headquarters, Geneva, Switzerland.

The principal writing and editorial team at WHO headquarters: Priyadarshani Galappatthy, Alpana Mair, Neelam Dhingra-Kumar, Minna Häkkinen-Wu, Ayda Taha, and Fumihito Takanashi.

Peer reviewers and other contributors, WHO headquarters: Pradeep Kumar Dua, Nikhil Gupta, Maki Kajiwara, Aradhana Kohli, Shanthi Narayan Pal, Irina Papieva, Liu Qin, Kim Sungchol and Isabelle Wachsmuth.

Contributors from international organizations: Michael R Cohen, Institute for Safe Medication Practices, USA; Helen Dowling, Australian Commission on Safety and Quality in health care; Carolyn Hoffman, Institute for Safe Medication Practices, Canada; Zuzana Kusynová, International Pharmaceutical Federation; Caroline Samer, International Union of Basic and Clinical Pharmacology; David U, International Medication Safety Network; and Steve Waller, Australian Commission on Safety and Quality in health care.

Contributors from WHO regional offices: Gertrude Avortri (WHO Regional Office for Africa), Mafaten Chaouali (WHO Regional Office for Europe), Jonas Gonseth-Garcia (WHO Regional Office for the Americas), Hyppolite Kalambay Ntembwa (WHO Regional Office for Africa), Pierre Claver Kariyo (WHO Regional Office for Africa), Angeliki Katsapi (WHO Regional Office for Europe), Mondher Letaief (WHO Regional Office for the Eastern Mediterranean), Nittita Prasopa-Plaizier (WHO Regional Office for the Western Pacific), Joao Joaquim Rodrigues da Silva Breda (WHO Regional Office for Europe), Aparna Singh Shah (WHO Regional Office for South-East Asia), Tomas Zapata (WHO Regional Office for Europe) and Evgeny Zheleznyakov (WHO Regional Office for Africa).

The external peer reviewers: Loubna Alj, Morocco; Nana Kwame Asiamah, Ghana; Shane Byrnes, Ireland; Mahesh Devnani, India; Lind Grant-Oyeye, Canada; Partha Gurumurthy, Botswana; Jesus Palacio Lapuente, Spain; Nagwa Metwally, Egypt; Victor Mosweu, Botswana; Abeer Muhanna, Saudi Arabia; Andrew Smith, United Kingdom; and Kazumi Tanaka, Japan.

Acronyms

CPOE	computerized prescriber order entry
HICs	high-income countries
ISMP	Institute for Safe Medication Practices
LASA	look-alike, sound-alike
LMICs	low- and middle-income countries
T&CM	traditional and complementary medicines
TML	"tall man" lettering
USA	United States of America
WHO	World Health Organization

Executive summary

Medication errors are a leading cause of patient harm globally. Look-alike, sound-alike (LASA) medicines are a well-recognized cause of medication errors that are due to orthographic (look-alike) and phonetic (sound-alike) similarities between medicines that can thus be confused. Look-alike medicines appear visually the same with respect to packaging, shape, colour and/or size, while sound-alike medicines are similar in the phonetics of their names, doses and/or strengths.

Confusions can occur between brand–brand, brand–generic or generic–generic names. The similarities could also occur with products coming under traditional and complementary medicines (T&CM). The appearance of medicines can be misleading, both because different medicines appear to be the same or because the same medicines appear to be different. This document provides information based on the best available evidence on the extent of this problem, the underlying causes and how to address them to prevent harm.

LASA errors can occur at any stage of medication use: prescribing, transcribing or documenting, dispensing, administering and monitoring. Poorly legible handwritten prescriptions, verbal orders, use of error-prone abbreviations and selection of a LASA medicine in computerized prescriber order entry (CPOE) are some of the main reasons for errors during prescribing. Similar appearance of medicines and their packaging, not colour coding of different strengths, and storage of LASA medicine pairs close to one another can result in LASA errors during dispensing. Unclear instructions for administration, failure to double-check the order and failure to monitor the patient after administration can lead to administration and monitoring errors. Failure to engage patients in their treatment at each stage of the medication use process results in LASA errors reaching the patients.

The potential outcomes of LASA errors include overdosing, underdosing or inappropriate dosing of unintended or intended medications. The impact on the patient will depend on the medicine administered and patient factors. Patients in extremes of age or with organ dysfunction are more vulnerable to errors and severe harm because of their particular physiology. Furthermore, they are more prone to make errors and be subjected to errors when dose modifications are required. The impact of LASA errors involving high-risk (high-alert) medicines will be serious and can cause severe patient harm, including death.

Table 1 lists the main actions that can be taken on medicines as products, by patients, health and care workers, health care institutions, facilities and countries to prevent or minimize LASA errors. Some of the actions are common to more than one area but are listed under only one, and several approaches may be necessary.

Table 1: Actions suggested for reducing LASA errors

Actions on medicines as products	Actions by patients, families and caregivers	Actions by health and care workers	Actions by health care facilities, institutions and countries
1. Use "tall man" lettering (TML) to label medicines with which a risk has been identified. 2. Segregate storage of identified LASA medicine pairs or groups. 3. Develop and use tools and skills to identify LASA medicine pairs to prevent registration of such products, minimize approval of several strengths of the same medicine, and approve only dosage forms and strengths with different appearances and packaging. 4. Identify LASA medicines when including them in formularies and during purchase for institutions and countries. 5. Prioritize LASA errors involving high-risk medicines with greater potential for severe harm. 6. Label all raw and processed T&CM products including the botanical names of plants	1. Know each medicine prescribed, dispensed and administered, including the name, indication, strengths of medicines dispensed and the dose to be used. 2. Be aware of potential errors with LASA medicines, and be vigilant about such errors. 3. Learn to label and store medicines appropriately at home to avoid LASA errors with the medicines dispensed to the patient. 4. Check with the health care provider if in doubt, about a prescribed, dispensed or administered LASA medicine.	1. Educate themselves and the patients about the LASA medicines that are prone to errors, and address them in practice. (The section on improving medication safety of the WHO patient safety curriculum guide is a good resource for this purpose). 2. Pay attention to LASA medicines when prescribing, dispensing and administering medicines and during medication reconciliation at transitions of care. 3. Use generic names during prescribing and transcribing to minimize errors due to brand name confusion. 4. Write legibly when prescribing and transcribing. 5. Attach clear labels for LASA medicines, with TML for medicines that could be confused.	1. Promote a just, trusting culture in facilities so that staff are at ease in discussing and reporting LASA medication errors and near misses. 2. Identify the most common pairs of LASA medicines in the country or organization, and update the list regularly. 3. Label clearly, use TML, and segregate storage of LASA medicines. 4. Take measures to avoid interrupting and distracting health and care workers while they are dispensing and administering medicines. 5. Include technology-based solutions, such as CPOE and barcoded dispensing, to avoid LASA errors. 6. Apply quality control measures to ensure proper use of authentic herbal medicines.

Each facility or institution should consider the barriers to and enablers of implementing the activities suggested. They will be specific to each facility and institution. Some barriers that facilities and institutions could consider include a "blame culture", staff fatigue, limited resources and the additional time necessary for staff for TML, labelling and segregating storage. A further barrier is the absence of processes to identify many confusing formulations or multiple strengths of the same medicine.

Enablers for reducing LASA errors include the support of institutions, regulators and manufacturers for considering LASA medicines as products that can be confused and staff training in LASA errors, including sharing information with patients and carers about lettering, packaging and storage that could result in LASA errors. Engaging patients and families in recognizing LASA errors, developing a positive reporting culture, and establishing systems and practices for active consideration of LASA medicines, (from procurement to use of medicines by patients) would also reduce LASA errors.

This publication on medication safety for LASA medicines is based on the best currently available evidence for action, which is presented when available. For most of the proposed solutions, however, the evidence was based on work conducted in controlled environments, and the suggestions are based mainly on expert consensus. More evidence, especially from real-life settings, would allow evidence-based strategies that could reduce errors due to LASA medicines.

1 Background

In recognition of the scale of avoidable harm linked with unsafe medication practices and medication errors, WHO launched the third Global Patient Safety Challenge: *Medication without harm*, in 2017, with the goal of reducing severe, avoidable medication-related harm by 50% over 5 years, globally *(1)*. The Challenge created the opportunity for leaders to drive change and work together to make a real difference to the lives of patients, families and front-line health workers. Furthermore, to consolidate the activities of the Challenge, "Medication safety" was selected as the theme for World Patient Safety Day 2022, with the slogan "*Medication without harm*".

Interventions are necessary at global, regional, national and facility levels and on the front line to address the Challenge, as the causes of medication errors are complex, with many contributing factors. Unsafe medication practices leading to medication errors jeopardize patient safety. A medication error is defined "as any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer. Such events may be related to professional practice, health care products, procedures, and systems, including prescribing, order communication, product labelling, packaging and nomenclature, compounding, dispensing, distribution, administration, education, monitoring, and use" *(2, 3)*.

1.1 Purpose and methods

This publication is part of a technical series on solutions to ensure medication safety. It is meant to provide a resource for health and care workers, policymakers, health care facilities, institutions and patient care organizations to understand the problem and impact of LASA medicines and to detect, address and prevent LASA errors. It also includes points for consideration by Member States, organizations, manufacturers and regulators.

A literature search was conducted up to March 2023 in PubMed, Google Scholar, Google and WHO publications with the keywords: look-alike sound-alike medicines, LASA medicines, medication errors and serious harm. The relevant references in the reference lists of key published articles on LASA medicines were retrieved and reviewed. Information related to LASA medicines available on the websites of major medicines regulatory authorities and of other relevant organizations, such as the Institute for Safe Medication Practices (ISMP), were also reviewed.

Expert opinion was obtained from relevant WHO units, WHO regional advisors and content experts. An advanced draft was sent for critical review to a wider group of reviewers and patients' representatives identified from the Global Patient Safety Network, representing all WHO regions, including low- and

middle-income countries (LMICs). All comments received were considered in revising the document. All external contributors and reviewers provided declarations of interests and signed confidentiality agreements, which were reviewed before they were invited to make contributions.

1.2 Look-alike, sound-alike (LASA) errors

Medication errors that occur when medicines have similar-looking or similar-sounding names, and/or shared features of products or packaging are called LASA errors *(4)*. LASA errors occur when the names of pairs or groups of medicines, such as cephalosporins, are similar in both their written forms (orthography) or their spoken names (phonology). Confusion can also occur between brand or generic names. Sound-alike errors are due to medicines with names that can easily be mistaken for those of others, especially when verbal orders are given *(4)*. There is, however, no universally accepted, clear definition of LASA errors. The appearance of medicines can be misleading because other medicines may look the same; conversely, the same medicine from a different source may look different. LASA medication errors can occur due to similarities in the medicine name, dosage form, strength or product packaging. These errors often occur due to selection of the wrong medicine from a shelf or even from an electronic list.

Adverse events may also arise during the use of T&CM products due to mistaken use of the wrong species of medicinal plants leading to incorrect dosing of raw herbs or finished products.

2 The problem

2.1 Introduction

LASA errors constitute a high proportion of all medication errors that can lead to significant patient harm *(4)*. In recognition of the problem, the Food and Drug Administration in the USA initiated a project for name differentiation in 2001 to evaluate post-marketing reports of confusion of name pairs *(5)*. Identification of LASA medicines is a requirement in medication management standards in many countries and health care settings. The ISMP issues a regularly updated list of LASA medicines, which can be used as a guide to identify LASA medicine pairs *(6)*. Many countries, both high-income countries (HICs) and LMICs now identify LASA medicines lists for their own settings *(7–11)*.

2.2 Examples

LASA errors often occur due to similarities in the letters that make up the names of different medicines or products, at the beginning, middle or end of the name (Table 2). Table 3 lists LASA medicine pairs identified in several countries, while Figure 1a and 1b presents some examples of LASA medicines identified in clinical settings.

Table 2: Mistaken letters in names of medicines

Location in the name	Letters	Examples of medicines
Beginning	Am	**Am**iloride, **Am**itriptyline, **Am**lodipine, **Am**iodarone
	Az	**Az**athioprine, **Az**ithromycin
	Carb	**Carb**imazole, **Carb**amazepine
	Pr	**Pr**ochlorperazine, **Pr**opranolol, **Pr**ednisolone, **Pr**omethazine
Middle	gaba	Pre**gaba**lin, Vi**gaba**trin
End	azole	Metronid**azole**, Omepr**azole**

Table 3: Examples of LASA medicine pairs identified in selected countries (non-proprietary or generic name is in parentheses)

Country	Brand name (generic name)	Brand name (generic name)
Australia	Avanza (mirtazapine) Losec (omeprazole)	Avandia (rosiglitazone) Lasix (furosemide)
Bangladesh	Maprocin (ciprofloxacin)	Macrocin (erythromycin)
Brazil	Losec (omeprazole) Quelicin (succinilcolina)	Lasix (furosemide) Keflin (cefalotina)
Canada	Celebrex (celecoxib) Losec (omeprazole)	Celexa (citalopram) Lasix (furosemide)
France	(fluoxetine)	(fluvoxamine)
India	Bandy (albendazole)	Candy (clindamycin)
Ireland	Losec (omeprazole) (morphine)	Lasix (furosemide) (hydromorphine)
Italy	Diamox (acetazolamide) Flomax (morniflumato)	Zimox (amoxicillin trihidrato) Volmax (salbutamolo solfato)
Japan	Almarl (arotinolol) Taxotere (docetaxel)	Amaryl (glimepiride) Taxol (paclitaxel)
Morocco	Prazol (omeprazole) Endoxan (cyclophosphamide)	Prozac (fluoxetine) Triaxon (ceftriaxone)
Spain	Dianben (metformin)	Diovan (valsartan)
Sweden	Avastin (bevacizumab) Lantus (insulin glargine)	Avaxium (hepatitis A vaccine) Lanvis (toguanine)

Source: WHO *(12)*.

Figure 1a: Examples of some injectable products of LASA medicines identified

Ketamine hydrochloride (general anaesthetic and sedative) and midazolam (benzodiazepine used as a sedative, and anxiolytic)

Bupivacaine (local anaesthetic) and sodium chloride (intravenous fluid used as a diluent or to flush after intravenous cannulation)

Figure 1b: Examples of tablets of LASA medicines identified from LMIC settings

Diclofenac sodium 50 mg (nonsteroidal anti-inflammatory drug used for pain relief) and bisoprolol 5 mg (beta-blocker used for cardiac failure and hypertension)

Gliclazide 80mg (anti diabetic medicine) and enalapril 5 mg (used for hypertension and heart failure) These medicines are re-packed from the original bulk packaging and kept for dispensing

Ciprofloxacin, levofloxacin (antibiotics) and several other medicines with similar appearance kept for dispensing

LASA errors can occur due to confusion of the following name combinations; most LASA pairs are reciprocal.

- generic–generic names; for example, propranolol and prednisolone, carbamazepine and carbimazole;
- brand–brand names, for example, Oxynorm and Oxycontin, Losec and Lasix; Celebrex and Cerebryx; and
- brand–generic names, for example, Malarone and mefloquine.

With respect to the clinical impact of confusion of these medicines pairs, giving propranolol instead of prednisolone to a patient with asthma has caused exacerbation of asthma and hypotension, due to propranolol aggravating bronchoconstriction and reducing blood pressure. Dispensing carbimazole, an antithyroid medicine to a patient prescribed carbamazepine for epilepsy can have potentially severe consequences as the patient can develop

hypothyroidism and loss of seizure control. The brand–brand confusion between Oxynorm and Oxycontin is an example of potential overdose if the modified release preparation (Oxycontin) is given in place of the normal release product (Oxynorm) at regular intervals. In the brand–generic example of Malarone and mefloquine, although both are used against malaria, harm has been seen when mefloquine used weekly was given daily instead of weekly. Losec is a brand name for omeprazole, an antiulcer treatment, while Lasix is a brand name for frusemide, a diuretic. Celebrex is a brand name for celecoxib, an anti-inflammatory medicine, while Cerebryx is a brand name for fosphenytoin, an anticonvulsant, which could also be confused with Celexa, a brand name for citalopram, an antidepressant. In these situations, a completely different medicine from what was intended could be dispensed if the prescription provides only the brand name, which could have serious consequences for the patient.

Furthermore, the same brand name in the same or a different country could have different active ingredients and may result in administration of a completely different medicine. For example, the brand name Medzol has been given to both pantoprazole and midazolam, two different medicines with different active ingredients (pantoprazole, an antiulcer medicine and midazolam, a sedative).

Sometimes, confusion can occur between two strengths of the same medicine. For example, warfarin is available in strengths ranging from 1 to 10 mg, which are usually colour coded. If colour coding is not used, serious errors could occur if 5-mg tablets are mistaken for 1-mg tablets or vice versa (Figure 2).

LASA errors could also occur with T&CM products, which are primarily based on medicinal plants. The confusions could occur with raw herbs (root, stem or leaf of plants), processed herbs (powders, extracts or infusions) or finished products (syrups, fermented liquids, or polyherbal formulations). Similarity in the colour, consistency, aroma and the taste of the pieces of raw herbs, powders or liquid herbal preparations and colour, shape, size of the tablets and capsules can contribute to LASA errors. Several medicinal plants are known by dissimilar common names in different languages in different parts of the world, which could lead to wrong identification.

Figure 2: An example of look-alike different strengths of warfarin, an anticoagulant and a high-risk medicine

Note: Warfarin tablets of 1, 3 and 5 mg of the same colour were supplied to hospitals in bulk containers in a LMIC and dispensed to patients as loose tablets. A patient was admitted with bleeding and an international normalizing ratio of 14.

2.3 Scale of errors

LASA errors are estimated to be responsible for 6.2–14.7% of all medication errors, with the prevalence of LASA errors in prescriptions varying from 0.00003% to 0.0022% *(4)*. In the United Kingdom, where over 1 billion prescriptions are issued each year, this error incidence was estimated to result in up to 2.2 million LASA errors annually *(4)*.

LASA errors often lead to administration of the wrong medicine at the wrong or incorrect dose of the intended medicine, leading to toxic effects or other adverse effects *(13,14)*. External environmental factors are not the cause, although they can increase the risk of an error due to LASA medicines *(15)*.

Quantitative evidence of the prevalence of LASA errors is limited, and various figures have been reported (Table 4).

Table 4: Reported prevalence rates of LASA errors

Rate of medication error due to LASA medicines	Type of study and reference
7% of medication near misses	Systematic evaluation of 2044 near misses (16)
15% of vaccine errors	Analysis of 607 error reports over 3 years in the USA (17)
0.0022% brand name confusion	Total of 244 brand name confusions among 113 346 errors reported in a study in Delhi, India (18).

3 Causes and impact of LASA errors

To address the errors due to LASA medicines, the instances in which they can occur must be identified. LASA errors occur during all stages of medication use.

3.1 Stages of medication use at which LASA errors can occur

LASA errors can occur at the stages of prescribing, transcribing or documenting, dispensing, administering and monitoring *(19)*. The common causes of LASA errors at each of these stages are listed below.

3.1.1 Prescribing

- Illegible or poorly legible handwritten prescriptions or orders, resulting in wrong interpretation (particularly in LMICs, where handwritten prescriptions are still used in most settings);
- Verbal and telephone orders for medications, resulting in potential confusion of sound-alike medications;
- Non engagement of patients and families in understanding and confirming the name and purpose of the medication;
- Incorrect selection of medicines from look-alike products during CPOE;
- Inappropriate use of error-prone abbreviations; for example, MSO_4 can be interpreted as magnesium sulphate or morphine sulphate, resulting in serious errors. (In one instance, $CaCO_3$ was interpreted as $LiCO_3$ on an unclearly handwritten prescription, and lithium carbonate was dispensed instead of calcium carbonate, resulting in development of lithium toxicity requiring dialysis. Writing only "U" for 'units' has led to misinterpretation of "6U insulin" as "60 units insulin", which resulted in severe hypoglycaemia.);
- Use of a trailing zero (for example, 5.0 mg can be interpreted as 50 mg) or non use of a zero (for example, .5 mg instead of 0.5 mg can be interpreted as 5 mg), leading to dosing errors.

3.1.2 Transcribing or documenting

- Incorrect transcription of a LASA medicine name;
- Use of inappropriate abbreviations in transcribing, leading to errors due to wrong interpretation of the abbreviation;
- Incorrect interpretation of sound-alike LASA medicines due to lack of a read-back mechanism during verbal and telephone orders.

3.1.3 Dispensing

- Selection of products according to where they are stored in the pharmacy or according to the packaging rather than the name and strength of the product;
- Storage of LASA medicines on the same shelf next to each other, which may be picked up incorrectly during dispensing;
- Changing the appearance or packaging of medicines, making them similar to other products;

- Non use of colour coding for different strengths and failure to recognize any changes in the usual strength or appearance of a product during dispensing;
- Failure to engage with patients to communicate the name and purpose of the medication;
- Failure to double-check accurately during dispensing due to time pressure, especially in LMICs when medicines are dispensed to a large number of patients during one session;
- Failure to communicate any changes in the appearance of medicines to patients.

3.1.4 Administering

- Unclear instructions for administration, for example, use of "as directed", leaving instructions open to misinterpretation;
- Unfamiliarity with medicines, leading to selection of a look-alike product;
- Selection of a product according to familiarity with the packaging or strength rather than confirming and double-checking the medicine name and the dose;
- Failure to engage patients during administration of medicines.

3.1.5 Monitoring

- Failure to monitor outcomes of medication by relevant clinical observations or biochemistry.

3.2 Clinical impact of LASA errors and vulnerable patients

The impact on the patient will depend on the medicine administered and the condition of the patient. LASA errors can result in toxicity due to overdosing of a medicine, adverse effects of an unintended medicine, and exacerbation of the disease for which the intended medicine was not given. Some errors are detected before the medicine is administered to a patient, while others are not found until much later. Errors might be more common where there is lack of familiarity with the products used *(20)*.

Some patient groups are more vulnerable to medication errors than others, for example due to their physiology in extremes of age, kidney or liver impairment, or frailty. Potential for harm is higher in paediatric or elderly patients because of differences in physiology causing differences in pharmacodynamics and pharmacokinetics. Some factors related to the type of medicines also make the patients more vulnerable to severe harm due to errors. These include medicines with a narrow therapeutic index, high-risk medicines, and medicines that are relatively more toxic, such as cancer medicines. The use of acronyms or nicknames to refer to cancer chemotherapy agents is also a potential source of error *(21)*. Patients in intensive care units and emergency departments are also particularly vulnerable to errors.

4 Addressing LASA errors

Limited evidence is available on the effectiveness of solutions for addressing the impact of LASA errors *(4)*. Although some regulatory bodies have taken steps to minimize allocation of LASA names and appearances to new products, situations can still arise in which similar names or appearances are assigned to medicines. Idiomatic variation can also result in LASA errors in different pairs, depending on the country. Similar packaging should also be considered a potential cause of error. As LASA products are already on the market, targeted strategies are necessary to reduce the risk of human error, with greater focus on a systems approach rather than a person-centred approach to human errors *(22)*.

A systems approach has been shown to be more effective in identifying the factors that are primarily responsible for a risk of error, known as "latent conditions" *(22)*. Latent conditions can result in two kinds of adverse effects: error-provoking conditions in the workplace (such as time pressure, understaffing, inadequate equipment, fatigue and inexperience) and long-lasting gaps or weaknesses in defences (for example, untrustworthy alarms and indicators, unworkable procedures, and design and construction deficiencies). Member States, in collaboration with regulators, can develop programmes to encourage their health and care institutions to address such latent conditions. National systems should be in place to encourage reporting, monitoring and evaluation of common LASA errors, with regular review and revision of common, country-specific pairs of LASA medicines.

Strategies to address LASA errors are considered below under the four domains of the WHO third Global Patient Safety Challenge: *Medication without harm*:

- Medicines: medicines as products;
- Patients and the public: role of patients and family members in preventing LASA errors;
- Health care professionals: role of health and care workers in preventing LASA errors;
- Systems and practices of medication: health care systems and practices to be addressed.

4.1 Medicines as products to be addressed

The most common reason for LASA errors is similarity in names and packaging. Regulators and the pharmaceutical industry both play roles in naming and packaging medicines. Many errors could be prevented if manufacturers considered risks for LASA errors when naming and designing packaging of medicines by adherence to regulatory guidance. This is especially important for risks that have already been identified.

4.1.1 Developing and updating the list of LASA medicines

Each country or Member State needs to identify the most common pairs of LASA medicines in their country or organizations that cause errors and update them regularly. Systematic methods have been used by countries and organizations to compile lists of such medicines *(4-8)*. Separate lists of LASA medicines can be identified for different specialities and settings (for example, for emergency care, intensive care units, maternal and newborn care, oncology units or community pharmacy settings). If compilation of a customized list is not possible, lists that have been developed by organizations such as the ISMP can be used *(6)*. Organizations and countries can issue and circulate regular bulletins to institutions to highlight and address any issues as they arise *(23)*.

4.1.2 "Tall man" lettering

One widely adopted approach for differentiating LASA medicine pairs is the use of TML, a term coined by ISMP *(24)*. TML assists in differentiating LASA medicine names by the use of upper-case lettering for certain letters of medicines names. This has often been applied to syllables or groups of letters within a medicine name to draw attention to dissimilarities between confusable names.

Regulatory authorities determine whether TML could be used to help differentiate similar names after evaluating post-marketing reports of name pair confusion *(5)*. Many factors, such as the degree of similarity of the names in a pair, the risks associated with name confusion, reports of medication errors, and causes or contributory factors, are considered during evaluation of name pairs. After evaluation, manufacturers can be requested to voluntarily revise their labels by using TML *(25,26)*. ISMP, which updates the LASA list regularly *(24)*, recommends use of TML in bold (Table 5). The list includes mostly generic–generic medicine name pairs, although some brand–brand or brand–generic name pairs are also listed, for voluntary use by health care workers, to prevent LASA errors *(26)*. Additional variations of TML, such as having letters in bold or in different colours, can be used for easy identification.

TML is the only intervention that has been evaluated for efficacy in preventing LASA errors in randomized controlled trials. Although the intervention is recommended and widely used, a systematic review of such trials found limited efficacy and concluded that TML is marginally effective for reducing LASA errors *(13)*.

Table 5: Some LASA medicine names recommended for "tall man" lettering

Established name	Recommended "tall man" lettering
Acetohexamide Acetazolamide	acetoHEXAMIDE acetaZOLAMIDE
Bupropion Buspirone	buPROPion busPIRone
Chlorpromazine Chlorpropamide	chlorproMAZINE chlorproPAMIDE
Clomiphene Clomipramine	clomiPHENE clomiPRAMINE
Cyclosporine Cycloserine	cycloSPORINE cycloSERINE
Daunorubicin Doxorubicin	DAUNOrubicin DOXOrubicin
Hydralazine Hydroxyzine	hydrALAZINE hydrOXYzine
Hydromorphone	HYDROmorphone
Medroxyprogesterone	medroxyPROGESTERone
Methylprednisolone Methyltestosterone	methylPREDNISolone methylTESTOSTERone

Source: Food and Drug Administration *(5)* and ISMP *(6)*.

4.1.3 Clear labelling, segregating storage and colour coding

The methods considered for addressing LASA errors are based mainly on expert opinion and consensus *(4,13)*. Those who use the policies are encouraged to collect evidence of their impact to contribute to the evidence base. If TML cannot be used (for example, for vaccines and immunoglobulins for a particular disease), the trade name on the label could differentiate the two products. Labelling that indicates possible LASA confusion can also help to identify medicines for which TML cannot be applied (Figure 3). Segregated storage of LASA medicine pairs may also help to avoid errors (Figure 4) *(27)*.

The few studies on use of a colour coding system provide little evidence that it reduces the risk of errors due to look-alike medicines *(28)*. There are far more look-alike medicines or medicine groups than there are colours that could be used. Most importantly, the evidence suggests that, when colour coding is used, health and care workers may rely solely on the colour of labels and not read them at all *(29,30)*. Despite the lack of evidence, an international standard recommends colour coding of medicines used in anaesthesia, and it appears to be the most widely used strategy for labelling such medicines in many countries, including Australia, New Zealand and the United Kingdom *(30–32)*.

In T&CM products the common name of every medicinal plant written in English need to be supported by its scientific/botanical name on the label. The small pieces of raw herbs used for making infusions and decoctions, processed herbs and finished products should be appropriately labelled to prevent errors in selection.

Figure 3: Labelling for LASA medicines in which "tall-man" lettering cannot be applied

Source: Pharmaceutical Services Division, Ministry of Health, Malaysia *(27)*

Note: Proprietary (brand or trademark) names may be added to distinguish medications. Non-proprietary names should be in larger font size than brand names.

Figure 4: Storage of LASA medicine pairs separately

Source: Pharmaceutical Services Division, Ministry of Health, Malaysia *(27)*

Note: Whenever possible, avoid storing LASA medicines close together.

4.2 Roles of patients and family members in preventing LASA errors

Poor medication literacy among patients may contribute to LASA errors. In a study conducted in a French region, 768 patients were interviewed. Although most patients identified medicines by their brand name (50%) and generic name (21%), some identified medicines by the physical appearance of the box (16%), tablet (7%) or blister packaging (3%) *(33)*. The factors considered most likely to cause confusion were the appearance of medicines, including look-alike tablets (28%), look-alike boxes (20%) and look-alike blister packaging (13%) *(33)*. Studies from LMICs indicate that patients in LMICs had much less knowledge than those in HICs about the medicines they took with only 42% identifying the medicines by their name *(34)*.

Patients and families should learn about the medicines prescribed to them and be vigilant about LASA errors, for their own safety. Patient safety organizations can educate patients about possible LASA errors. Reporting of LASA errors by patients to the relevant authorities can assist the authorities in learning from errors and in identifying local LASA pairs to prevent similar errors.

Patients should also appreciate that the same medicine from different sources may have different appearances. This will help patients to avoid overdosing by taking the same medicine from two sources and with different physical appearances and may also help to improve adherence to a medicine with a familiar appearance that is different when manufactured by another source.

Among consumers, there is a widespread misconception that T&CM products are 'natural' and hence 'safe' and carry no risk. However, errors in selection of T&CM products and usage of incorrect and inappropriate T&CM products can lead to unwanted effects and public should be aware of this.

4.3 Roles of health and care workers in preventing LASA errors

Health and care workers around the world should be aware of LASA medicines and prevent errors in their practice. They should attach clear labelling and segregate storage of LASA medicines to ensure differentiation.

4.3.1 Training of health and care workers

Lack of training or staff fatigue can contribute to LASA errors. The section on "improving medication safety" in the WHO publication, *Patient safety curriculum guide, multi-professional edition (35)* is a good resource for teaching and learning, as it addresses common causes of medication errors and strategies for preventing patient harm. Potential LASA errors should be included in graduate and postgraduate educational curricula and in continuing professional development for all categories of health care providers. Health and care workers from all backgrounds should consider LASA errors when selecting medicines during prescribing, dispensing and when administering medicines. Research, including systematic reviews that included low-resource settings, has shown that, when users are aware of the purpose and use of TML, they are less likely to confuse look-alike names and more likely to derive benefit from TML *(20,36,37)*. Health and care workers should improve the understanding of patients of potential LASA errors at home, thus helping to prevent such errors. Development of a culture in which health and care workers listen to patients and their carers when they share information about administration of their medicines is important in preventing LASA errors *(38)*.

Health care professionals, especially pharmacists and nurses, should be trained in attaching clear labels with TML for LASA medicines and storing different strengths of the same medicine with similar packaging separately to avoid errors, especially for high-risk medicines. TML should be used when a risk has been identified and not in all circumstances *(41)*.

To engage patients and families, health and care workers can:

- educate patients, families and caregivers about potential LASA errors and remind them to double-check the names of their medicines;
- teach them about use of TML on labels to help them identify the names clearly, even at home;
- educate them about the names used for their medicines, (brand name and generic name, as well as the clinical indication) so that patients are engaged in ensuring that they receive the correct medication;
- support patients, families and caregivers in speaking about their medicines if they suspect any unexpected change;

- educate patients about the problems of LASA medicine names so that they are aware before ordering medicines via the internet or in pharmacies, and encourage them to purchase medicines from regulated, authorized premises; and
- encourage patients to enquire about medicines from their community pharmacists or health and care workers, to seek information about LASA medicines, and to keep a list of the medicines they are prescribed to prevent LASA errors related to their medications.

4.3.2 Roles of regulators, naming bodies and manufacturers

Regulators, naming bodies and manufacturers play vital roles in ensuring that factors related to LASA medicines are considered during product development and approval.

- Regulators are responsible for monitoring the naming and packaging of new products to avoid LASA medicine errors. They are supported by an international approach and discussion that allows LASA medicine pairs to be identified at the pre-marketing stage *(40)*.
- Phonetic and orthographic computer analysis can assist in naming new products, including consideration of variations in the products used in different countries. Phonetic and orthographic computer analysis does not, however, address the problem posed by existing products.
- The medicines regulatory authority in a country can prevent registration of products with the same brand names but that contain different active ingredients or different strengths of medicines having the same appearance (see Figure. 2).
- Naming bodies, such the WHO International Non-proprietary Names programme and the British Pharmacopoeia, can prevent designation of highly confusable name pairs *(41,42)*.
- Manufacturers and suppliers should consider LASA errors when naming and packaging generic and branded medicines.
- Regulators can develop tools and skills to identify medication errors from reports of adverse incidents from health care facilities and investigate their preventability *(43)*.
- Ensuring a similar appearance of generic products of the same medicine would also aid in identification of the same medicines from different sources. The Food and Drug Administration in the USA encourages generic manufacturers of the same medicine to ensure that their products have similar physical characteristics *(44)*. Regulatory authorities recommend that sufficient visibility be given to generic names to facilitate identification, even if the proprietary name is different *(45)*.

4.4 Health care systems and practices to be addressed

A just and trusting culture is fundamental to patient safety in an organization. By ensuring that staff are at ease in discussing and reporting potential LASA errors, the organization can prevent the same or similar types of error from occurring. Staff must also be supported in proposing contributing factors and underlying reasons, such as a high workload, psychological aspects and identifying products prone to errors in their clinical settings. Addressing such areas encourages health workers to report errors and near misses (43). A whole-systems approach should be applied in identifying and addressing situations throughout the health care system that could increase the likelihood of a LASA error. An example is an emergency department or a busy pharmacy, where more LASA errors could occur due to time constraints and a heavy workload. Steps to improve systems and practices can contribute to preventing errors in these high-risk situations.

Actions to address errors due to LASA medicines that could be implemented throughout a health care system are given below.

Avoid interruptions, distractions and verbal orders *(15, 25, 46, 47):*

- If verbal orders cannot be avoided, repeat the name out loud to confirm the exact verbal order and clarify the name.
- Use signs stating "do not disturb" or "no interruptions" during medicines dispensing and administration; this intervention has had various degrees of success, and there is also concern that it could discourage patients from asking relevant questions.
- Use reminders and alerts for LASA medicines.
- Be aware that high-intensity environments, such as emergency departments, operating theaters and intensive care units, are particularly prone to LASA errors.

Write legible prescriptions, and avoid use of error-prone abbreviations *(48-50)*.

- If feasible, reduce the number of handwritten orders.

- Write the names of medicines, dosage directions and route of administration legibly and consider adding the indication to prescriptions to check the appropriateness of the prescription and to ensure that LASA medicines are not confused.
- Verify prescriptions, for example by checking with the patient and reviewing the indication before dispensing and administration.
- Record the identification of the prescriber (for example, by using a seal) in both government and private sectors to facilitate clarifying any doubts about a prescription.
- Be aware that poorly legible prescriptions and use of error-prone abbreviations are particular problems in LMICs, where most prescriptions are written by hand.

Address packaging and labelling of LASA medicines, and provide information, education and communication material *(51–55).*

- Use typographic interventions, such as TML.
- Use stickers with symbols or pictograms on packaging or signage on pharmacy shelves.
- Relabel medicines to include brand and generic names and use clear signage on pharmacy shelves.
- If possible, request manufacturers and suppliers to revise the labelling, appearance and packaging of their products, when similarities are noted (see figure 5).
- Display information, education and communication material about LASA errors and how to address them on boards, posters and other media at prominent places, especially in pharmacies and critical care areas.

Change the storage of medicines *(46,56).*

- Change the sequence of storage of medicines with similar sounding names, especially those with a narrow therapeutic ratio.
- Segregate LASA medicines pairs or groups of medicines, such as cephalosporins.
- Use stickers with techniques such as TML, boldface and colour differences to reduce the confusion associated with LASA medicines on labels, storage bins, shelves, computer screens, automated dispensing devices and medication administration records.
- Use colour coding to differentiate medicines, although a combination of techniques is advisable, especially for people who are colour blind.

Review LASA medicines during registration of products, when including products in formularies, or during procurement of medicines *(24,54).*

- Review potential problems before registering new products or adding them to a formulary, including when introducing changes because of medicines shortages.
- Avoid adding several dosage forms of the same medicine and limit the number of dosage forms and strengths available for adult and for paediatric use.
- When procuring medicines, avoid purchasing medicines with similar packaging and appearance if possible; when introducing new products or packages, compare them with existing packaging.

Figure 5: Revision of labelling and appearance of LASA medicines to minimize the risk of potential serious errors

Panel A Panel B

Source: Gangakhedkar et al. *(56).*

Note: Three high-risk medicines – rocuronium (muscle relaxant used in anaesthesia), midazolam (sedative) and heparin (anticoagulant) – in similar bottles, (Panel A) with their appearances changed by differences in labelling and having caps of different colours after recognition of their similarity and the ensuing risks (Panel B).

Use technology-based solutions to address LASA medicines *(57–61)*

- Design CPOE systems to ensure that LASA medicines are not placed next to each other on the computer drop-down options and use other algorithms that can reduce errors.
- Use indication alerts to intercept errors in medicine names and exercise caution to avoid alert fatigue during CPOE.
- Use barcoding during dispensing to correlate physical selection of a product with that on the screen; however, checks should still be made, as this will not address errors occurring before dispensing, such as during prescribing.
- Consider use of automated dispensing cabinets and robotic dispensing as a possibly useful intervention to prevent dispensing errors.
- Use barcoding technology during administration (when barcodes are added to products and to unit dosages) with international standards for coding.
- Use a system for identifying pharmaceutical products, when available, to reduce error; establishment of a global pharmaceutical product identification system is being discussed in the WHO Identification of Medicinal Products initiative *(60, 61)*.

Undertake medication review and medication reconciliation *(62,63)*.

- Perform a medication review when initiating medications and at transitions of care.
- Train pharmacists and other health and care workers to address potential LASA errors on the wards and at points of transition by performing medication reconciliation, sharing information with patients and staff.

Ensure that all staff are properly trained and are aware of possible LASA errors and interventions to avoid them.

Employ qualified, competent individuals for all steps in medication use and management in health care settings.

- Be aware that shortage of staff in many LMICs has required the use of (often untrained and unqualified) informal health care providers to assist health and care workers, increasing the risk of LASA errors; training of all categories of staff, including informal health care providers involved in handling medicines is required, on possible LASA errors and ways of preventing them.

Report medication error incidents *(43,47)*.

- Report medication error incidents and near misses in health care facilities by health and care workers and by patients to the relevant authorities, in a "no blame" culture.
- Perform root cause analysis by a multidisciplinary team to learn from errors and to implement coordinated actions to prevent common errors.
- Strengthen pharmacovigilance programmes and patient safety organizations to ensure that they report medication errors and near misses.
- Report errors related to T&CM products to learn from those and to take preventive actions.

4.5 Additional points for consideration by Member States and organizations

Additional advocacy that can be taken to address LASA medicines is as follows:

- Ensure that organizations responsible for procuring medicines include considerations of potential LASA errors in acquisition of new products.
- Be aware that a single brand name may be associated with different medicines in different countries.
- Advocate for increased emphasis on patient safety in the naming of medicines and for elimination of LASA names by participating in national and international regulatory, standards and advisory boards.
- Collaborate with international regulatory agencies and industries to develop a uniform naming process and safety culture *(64)*. This would require:
  - a universal medicine naming convention;
  - screening of existing medicines names for potential confusion with a new medicine name before approval of the latter;
  - standardized suffixes (for example, for sustained-release medicines);
  - ensuring that potential LASA confusions are considered when medicines are introduced; and
  - considering possible LASA errors due to similarities in packaging.

5 Barriers and enablers

Each facility or institution should consider the barriers to and enablers of implementation of solutions to LASA errors. The lists below are not exhaustive, but facilities and institutions may consider them when developing solutions to LASA errors.

5.1 Barriers

- blame culture;
- inadequate staff resources for TML and segregation of LASA medicine pairs in storage;
- lack of appropriate formulations or strengths (for example, paediatric doses or formulations and different bolus and maintenance formulations);
- inadequate resources, especially in LMICs, to implement technological solutions such as CPOE and barcoding;
- wide variation in pharmaceutical regulations among countries;
- lack of a standard method for TML;
- physicians' preference for prescribing brand rather than generic names; and
- insufficient evidence on solutions for LASA errors.

5.2 Enablers

- staff training, including sharing information about lettering and packaging with patients and carers to minimize errors;
- a positive reporting culture;
- active consideration of LASA errors when procuring medicines;
- commitment of policy-makers and health care leaders to minimize LASA errors; and
- collaboration among regulatory authorities and responsible organizations to avoid LASA errors during naming and packaging of medicines.

References

1. Donaldson LJ, Kelley ET, Dhingra-Kumar N, Kieny MP, Sheikh A. Medication without harm: WHO's third global patient safety challenge. Lancet. 2017;389(10080):1680–1. *https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(17)31047-4/fulltext*
2. About medication errors: what is a medication error? National Coordinating Council for Medication Error Reporting and Prevention; 2022 (*https://www.nccmerp.org/about-medication-errors*, accessed 23 March 2023).
3. Conceptual framework for the international classification for patient safety, version 1.1: final technical report, January 2009. Geneva: World Health Organization; 2010. (*https://apps.who.int/iris/handle/10665/70882* accessed 23 March 2023).
4. Bryan R, Aronson JK, Williams A, Jordan S. The problem of look-alike sound alike name errors: drivers and solutions. British Journal of Clinical Pharmacology. 2021;87:386–94. (*https://bpspubs.onlinelibrary.wiley.com/doi/full/10.1111/bcp.14285* accessed on 12 March 2023).
5. FDA Name Differentiation Project. FDA list of established drug names recommended to use tall man lettering (TML). United States Food and Drug Administration; (*https://www.fda.gov/drugs/medication-errors-related-cder-regulated-drug-products/fda-name-differentiation-project*, accessed 30 March 2023).
6. Institute for Safe Medication Practices. Look-alike drug names with recommended tall man letters. (*https://www.ismp.org/recommendations/tall-man-letters-list*, accessed 22 March 2023).
7. Heck J, Groh A, Stichtenoth DO, Krause O. Proposal of a tall man letter list for German-speaking countries. European Journal of Clinical Pharmacology. 2021;77(8):1247–9. (*https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8275545/pdf/228_2021_Article_3091.pdf* accessed on 12 March 2023).
8. Emmerton L, Rizk MF, Bedford G, Lalor D. Systematic derivation of an Australian standard for tall man lettering to distinguish similar drug names. Journal of Evaluation in Clinical Practice. 2015;21(1):85–90. (*https://onlinelibrary.wiley.com/doi/abs/10.1111/jep.12247* accessed 12 March 2023).
9. Rahman Z, Parvin R. Medication errors associated with look-alike/sound-alike drugs: a brief review. Journal of Enam Medical College. 2015;5(2):110–7. *https://www.banglajol.info/index.php/JEMC/article/view/23385*
10. Naik NA, Pranay W, Kumari P, Ankita W. Look alike and sound alike names of branded medicines in Indian pharmaceutical market. Journal of Pharmaceutical Research. 2009;8(3):134–8. *https://sciresol.s3.us-east-2.amazonaws.com/srs-j/jpr/pdf/volume8/issue3/JPR116.pdf*
11. Dixit SM. Look-alike and sound-alike medicines: let us all be aware. Journal of Kathmandu Medical College. 2013;2(2):75–83. *https://jkmc.com.np/ojs3/index.php/journal/article/view/869*
12. World Health Organization. Look-alike Sound alike medicines. (*https://cdn.who.int/media/docs/default-source/patient-safety/patient-safety-solutions/ps-solution1-look-alike-sound-alike-medication-names.pdf?sfvrsn=d4fb860b_8&download=true*. Accessed 23 March 2023).

13. Bryan R, Aronson JK, Williams A, Jordan S. A systematic literature review of LASA error interventions. British Journal of Clinical Pharmacology. 2021;87(2):336–51. https://bpspubs.onlinelibrary.wiley.com/doi/abs/10.1111/bcp.14644

14. Aronson JK. Medication errors: EMERGing solutions. British Journal of Clinical Pharmacology. 2009;67(6):589–91. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2723194/

15. Alteren J, Hermstad M, White J, Jordan S. Conflicting priorities: observation of medicine administration. Journal of Clinical Nursing. 2018;27(19–20):3613–21. https://onlinelibrary.wiley.com/doi/abs/10.1111/jocn.14518

16. Smith HS, Lesar TS. Analgesic prescribing errors and associated medication characteristics. Journal of Pain. 2011;12(1):29–40. https://www.sciencedirect.com/science/article/abs/pii/S152659001000489X

17. Bundy DG, Shore AD, Morlock LL, Miller MR. Pediatric vaccination errors: application of the "5 rights" framework to a national error reporting database. Vaccine. 2009;27(29):3890–6. https://www.sciencedirect.com/science/article/pii/S0264410X09005404

18. Joshi MC, Joshi HS, Tariq K, Ejaj A, Prayag S, Raju A. A prospective study of medication errors arising out of look-alike and sound-alike brand names confusion. International Journal of Risk and Safety in Medicine. 2007;19(4):195–201. https://content.iospress.com/articles/international-journal-of-risk-and-safety-in-medicine/jrs416

19. Moore SJ, Jenkins AT, Poppe LB, Rowe EC, Eckel SF. Significant publications about the medication use process in 2012. Journal of Pharmacy Practice. 2015;28(4):387–97.https://journals.sagepub.com/doi/abs/10.1177/0897190013519821?journalCode=jppa

20. Filik R, Price J, Darker I, Gerrett D, Purdy K, Gale A. The influence of tall man lettering on drug name confusion: a laboratory-based investigation in the UK using younger and older adults and health care practitioners. Drug Safety. 2010;33(8):677–87. https://link.springer.com/article/10.2165/11532360-000000000-00000

21. Look-alike, sound-alike drugs in oncology. Journal of Oncology Pharmacy Practice. 2011;17:104–18. https://journals.sagepub.com/doi/pdf/10.1177/1078155209354135

22. Reason J. Human error: models and management. BMJ. 2000;320(7237):768–70. https://www.bmj.com/content/320/7237/768

23. Institute for Safe Medication Practices Canada. Brand name change for dabigatran: Pradax is now Pradaxa. In: Intravenous phenytoin: rate of administration is critical. ISMP Canada Safety Bulletin. 2013;13:1 (https://www.ismp-canada.org/download/safetyBulletins/2013/ISMPCSB2013-01_Intravenous_Phenytoin.pdf, accessed 30 March 2023).

24. Special edition: Tall man lettering: ISMP updates its list of drug names with tall man letters. Institute for Safe Medication Practices article, 2 June 2016 (https://www.ismp.org/resources/special-edition-tall-man-lettering-ismp-updates-its-list-drug-names-tall-man-letters, accessed 30 March 2023).

25. Adopt Strategies to Manage Look-Alike and/or Sound-Alike Medication Name Mix-Ups (https://www.ismp.org/resources/adopt-strategies-manage-look-alike-andor-sound-alike-medication-name-mix-ups accessed 22 March 2023).

26. Look-alike drug names with recommended tall man letters. Institute for Safe Medication Practices article, 20 November 2016 https://www.ismp.org/sites/default/files/attachments/2017-11/tallmanletters.pdf accessed 23 March 2023).

27. Guide on handling look alike, sound alike medications. Pharmaceutical Services Division, Ministry of Health, Malaysia: 2012 (https://www.pharmacy.gov.my/v2/sites/default/files/document-upload/guide-handling-lasa.pdf, accessed 23 March 2023).

28. Filiatrault P. Does colour-coded labelling reduce the risk of medication errors? Canadian Journal of Hospital Pharmacy. 2009;62(2):154–5. https://www.cjhp-online.ca/index.php/cjhp/article/view/446

29. da Rocha BS, Moraes CG, Okumura LM, da Cruz F, Sirtori L, da Silva Pons E. Interventions to reduce problems related to the readability and comprehensibility of drug packages and labels: a systematic review. Journal of Patient Safety. 2021 Dec 1;17(8):e1494-506. https://journals.lww.com/journalpatientsafety/Abstract/2021/12000/Interventions_to_Reduce_Problems_Related_to_the.114.aspx

30. ISO 26825:2008 – Anaesthetic and respiratory equipment – User-applied labels for syringes containing drugs used during anaesthesia – colour design and performance. Geneva: International Organization for Standardization; 2008. (https://www.iso.org/standard/76678.html accessed 25 March 2023).

31. Birks RJ, Simpson PJ. Syringe labelling: an international standard. Anaesthesia. 2003;58(6): 518–9. https://associationofanaesthetists-publications.onlinelibrary.wiley.com/doi/full/10.1046/j.1365-2044.2003.03259.x

32. A joint statement supporting user-applied labelling standardisation for all injectable medicines and fluids. Australian Commission on Safety and Quality

in health care and Australian and New Zealand College of Anaesthetists; 2013 (https://www.safetyandquality.gov.au/sites/default/files/migrated/Joint-statement-supporting-user-applied-labelling-standardisation-for-all-injectable-medicines-and-fluids-January-2017.pdf, accessed 25 March 2023).

33. Tranchard F, Gauthier J, Hein C, Lacombe J, Brett K, Villars H et al. Drug identification by the patient: perception of patients, physicians and pharmacists. Therapies. 2019;74(6):591–8. https://www.sciencedirect.com/science/article/abs/pii/S0040595719300587

34. Thevarajah. R, Haputhanthri IU, Misbahunnisa M. Y, Galappatthy P (2022) Patients' knowledge about medicines improves when provided with written compared to verbal information in their native language. PLoS ONE 17(10): e0274901. https://doi.org/10.1371/journal.pone.0274901 https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0274901

35. Patient safety curriculum guide: multi-professional edition. Geneva: World Health Organization; 2011 (https://www.who.int/publications/i/item/9789241501958, accessed 25 March 2023).

36. DeHenau C, Becker MW, Bello NM, Liu S, Bix L. Tall man lettering as a strategy for differentiation in look-alike, sound-alike drug names: the role of familiarity in differentiating drug doppelgangers. Applied Ergonomics. 2016;52:77–84. https://www.sciencedirect.com/science/article/pii/S0003687015300119

37. Larmené-Beld KHM, Kim Alting E, Taxis K. A systematic literature review on strategies to avoid look-alike errors of labels. European Journal of Clinical Pharmacology. 2018;74:985–93. https://link.springer.com/article/10.1007/s00228-018-2471-z

38. Mosakazemi SZ, Bastani P, Marzaleh MA, Peyravi MR. A survey on the frequency of medication errors caused due to look-alike drugs in the emergency department of the educational hospitals of Shiraz, Iran. Iranian Journal of Health, Safety and Environment. 2016;6(1):1167–74. http://ijhse.ir/index.php/IJHSE/article/view/358

39. Principles for application of TALL man lettering in Canada. Institute for Safe Medication Practices Canada; 2016 (https://www.ismp-canada.org/download/TALLman/PrinciplesApplication-TALLmanLettering-Mar2016.pdf, accessed 30 March 2023).

40. Guidance document for industry: review of drug brand names. Health Canada; 2014 (https://www.canada.ca/en/health-canada/services/drugs-health-products/reports-publications/medeffect-canada/guidance-document-industry-review-drug-brand-names.html, accessed 25 March 2023).

41. International nonpropriety names programme and classification of medical products. Geneva: World Health Organization (https://www.who.int/teams/health-product-and-policy-standards/inn, accessed 25 March 2023).

42. Bryan R, Aronson JK, ten Hacken P, Williams A, Jordan S. Patient safety in medication nomenclature: orthographic and semantic properties of international nonproprietary names. PLoS One. 2015;10(12):e0145431. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0145431

43. Reporting and learning systems for medication errors: the role of pharmacovigilance centres. Geneva: World Health Organization; 2014 (https://apps.who.int/iris/handle/10665/137036, accessed 31 August 2022).

44. Size, shape, and other physical attributes of generic tablets and capsules. Guidance document. United States Food and Drug Administration; 2015 (http://www.fda.gov/downloads/Drugs/GuidanceComplianceRegulatoryInformation/Guidances/UCM377938.pdf, accessed 25 March 2023).

45. Design for patient safety: a guide to the graphic design of medication packaging. National Patient Safety Agency, National Health Service; 2014 (https://www.yumpu.com/en/document/view/29529122/a-guide-to-the-graphic-design-of-medication-packaging, accessed 25 March 2023).

46. Tuohy N, Paparella S. Look-alike and sound-alike drugs: errors just waiting to happen. Journal of Emergency Nursing. 2005;31(6):569–71. https://www.intljourtranur.com/article/S0099-1767(05)00437-X/fulltext

47. Kurttila M, Saano S, Laaksonen R. Reminding staff of diligence during the medication process is not enough to ensure safety: Learning from wrong fluid product selection incidents in the care of critically ill patients. Exploratory Research in Clinical and Social Pharmacy. 2022 Dec 1;8:100181. https://www.sciencedirect.com/science/article/pii/S2667276622000804

48. Rathish D, Bahini S, Sivakumar T, Thiranagama T, Abarajithan T, Wijerathne B et al. Drug utilization, prescription errors and potential drug-drug interactions: an experience in rural Sri Lanka. BMC Pharmacology and Toxicology. 2016;17(1):27. https://bmcpharmacoltoxicol.biomedcentral.com/articles/10.1186/s40360-016-0071-z

49. Samaranayake NR, Dabare PR, Wanigatunge CA, Cheung BM. The pattern of abbreviation use in prescriptions: a way forward in eliminating error-prone abbreviations and standardisation of prescriptions. Current Drug Safety. 2014;9(1): 34–42. https://www.ingentaconnect.com/content/ben/cds/2014/00000009/00000001/art00006

50. Samaranayake NR, Cheung DS, Lam MP, Cheung TT, Chui W, Wong IC et al. The effectiveness of a "Do Not Use" list and perceptions of health care professionals on error-prone abbreviations. International Journal of Clinical Pharmacy. 2014;36(5):1000–6. *https://link.springer.com/article/10.1007/s11096-014-9987-9*

51. Ciociano N, Bagnasco L. Look alike/sound alike drugs: a literature review on causes and solutions. International Journal of Clinical Pharmacy. 2014;36(2):233–42. *https://link.springer.com/article/10.1007/s11096-013-9885-6*

52. Filik R, Purdy K, Gale A, Gerrett D. Labelling of medicines and patient safety: evaluating methods of reducing drug name confusion. Human Factors. 2006;48(1):39–47. *https://journals.sagepub.com/doi/abs/10.1518/001872006776412199?journalCode=hfsa*

53. Irwin A, Mearns K, Watson M, Urquhart J. The effect of proximity, tall man lettering, and time pressure on accurate visual perception of drug names. Human Factors. 2013;55(2):253–66. *https://journals.sagepub.com/doi/pdf/10.1177/0018720812457565*

54. Shah MB, Merchant L, Chan IZ, Taylor K. Characteristics that may help in the identification of potentially confusing proprietary drug names. Therapeutic Innovation and Regulatory Science. 2017;51(2):232–6. *https://journals.sagepub.com/doi/pdf/10.1177/2168479016667161*

55. Gangakhedkar GR, Waghalkar PV, Shetty AN, Dalvi AM. Look alike drugs: avoiding potential medical errors. International Journal of Preventive Medicine. 2019;10(1):10–19. *https://www.proquest.com/openview/a3896c12f3be42302a623f7ec5ed9622/1?pq-origsite=gscholar&cbl=1566339*

56. Irwin A, Mearns K, Watson M, Urquhart J. Pharmacist dispensing error: the effect of neighbourhood density and time pressure on accurate visual perception of drug names. Proceedings of the Human Factors and Ergonomics Society Annual Meeting. 2011;55(1):1621–5. *https://journals.sagepub.com/doi/pdf/10.1177/1071181311551338*

57. Imbo S. *A Novel Decision Algorithm for Reducing Medication Errors in CPOE Systems* (Doctoral dissertation, 2019 Rutgers The State University of New Jersey, Rutgers School of Health Professions). *https://rucore.libraries.rutgers.edu/rutgers-lib/59904/PDF/1/play/* accessed 25 March 2023.

58. Galanter WL, Bryson ML, Falck S, Rosenfield R, Laragh M, Shrestha N et al. Indication alerts intercept drug name confusion errors during computerized entry of medication orders. PLoS One. 2014;9(7):e101977. *https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0101977*

59. Ruutiainen HK, Kallio MM, Kuitunen SK. Identification and safe storage of look-alike, sound-alike medicines in automated dispensing cabinets. European Journal of Hospital Pharmacy. 2021;28(e1):e151–6. *https://ejhp.bmj.com/content/ejhpharm/28/e1/e151.full.pdf*

60. Notes from a workshop on the identification of medicinal products (IDMP), 11–12 September 2019, WHO, Geneva. Geneva: World Health Organization; 2019 (*https://admin.iprp.global/sites/default/files/2020-04/IPRP_IDMPWG_Minutes_11-12Sep2019Workshop_2020_0310.pdf*, accessed 25 March 2023).

61. IDMP frequently asked questions. International Pharmaceutical Regulators Programme (IPRP) Identification of Medicinal Products (IDMP) Working Group; 2021 (*https://admin.iprp.global/sites/default/files/2021-12/IDMPWG_FAQ_v3_2021_1029.pdf*, accessed 25 March 2023).

62. Medication safety in polypharmacy. WHO/UHC/SDS/2019.11. Geneva: World Health Organization; 2019.(*https://www.who.int/publications/i/item/WHO-UHC-SDS-2019.11* accessed 25 March 2023).

63. Medication safety in transitions of care. WHO/UHC/SDS/2019.9. Geneva: World Health Organization; 2019 (*https://www.who.int/publications/i/item/WHO-UHC-SDS-2019.9* accessed 25 March 2023).

64. Lizano-Díez I, Figueiredo-Escribá C, Piñero-López M, Lastra CF, Mariño EL, Modamio P. Prevention strategies to identify LASA errors: building and sustaining a culture of patient safety. BMC Health Services Research. 2020;20(1):1–5. *https://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-020-4922-3*

Annex: glossary

Term	Definition and source used (see references below)
Adverse drug event	Any injury resulting from medical interventions related to a drug. This includes both adverse drug reactions in which no error occurred and complications resulting from medication errors *(1)*.
Adverse drug reaction	A response to a drug which is noxious and unintended and that occurs at doses used in humans for prophylaxis, diagnosis or therapy of diseases, or for the modification of physiological function *(2)*. These are often classified as two types *(3)*: Type A adverse drug reaction: an augmented pharmacologically predictable reaction that is dose dependent. It is generally associated with high morbidity and low mortality *(4)*. Type B adverse drug reaction: a bizarre reaction that is unpredictable pharmacologically and is independent of dose. It is generally associated with low morbidity and high mortality *(4)*.
Formulary	A list of medicines, usually by their generic names, and indications for their use. A formulary is intended to include a sufficient range of medicines to enable medical practitioners, dentists and, as appropriate, other practitioners to prescribe all medically appropriate treatment for all reasonably common illnesses *(5)*.
High-risk (high-alert) medications	Drugs that bear a heightened risk of causing significant patient harm when they are used in error. Although mistakes may or may not be more common with these medications, the consequences of an error are clearly more devastating to patients *(6)*.
Medication error	Any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer. Such events may be related to professional practice, health care products, procedures, and systems, including prescribing, order communication, product labelling, packaging and nomenclature, compounding, dispensing, distribution, administration, education, monitoring, and use. *(7)*.
Medication reconciliation	The formal process in which health care professionals partner with patients to ensure accurate and complete medication information transfer at interfaces of care *(8)*.
Medication-related harm	Patient harm related to medication *(9)*. It includes preventable adverse drug events (for example, due to a medication error or accidental or intentional misuse) and non-preventable adverse drug events (for example, an adverse drug reaction).

Term	Definition and source used (see references below)
Medication review	A structured evaluation of a patient's medicines with the aim of optimizing medicine use and improving health outcomes. This entails detecting drug-related problems and recommending interventions *(10)*.
Medication safety	Freedom from accidental injury during the course of medication use; activities to avoid, prevent, or correct adverse drug events that may result from the use of medications *(11)*.
Medication use process	The multistep process in the use of medications by or for patients, including prescribing, ordering, storage, dispensing, preparation, administration and Monitoring *(12)*.
Near miss	An incident that did not reach the patient *(13)*.
Patient safety	The absence of preventable harm to a patient and reduction of risk of unnecessary harm associated with health care to an acceptable minimum. An acceptable minimum refers to the collective notions of given current knowledge, resources available, and the context in which care was delivered weighed against the risk of non-treatment or other treatment *(13)*.
Pharmacovigilance	Science and activities relating to the detection, assessment, understanding and prevention of adverse effects or any other drug-related problem *(2)*.
Safety	The reduction of risk of unnecessary harm to an acceptable minimum *(14)*.
Transitions of care	The various points where a patient moves to, or returns from, a particular physical location or makes contact with a health care professional for the purposes of receiving health care *(8)*.

Glossary references

1. Bates DW, Boyle DL, Vander Vliet MB, Schneider J, Leape L. Relationship between medication errors and adverse drug events. Journal of General Internal Medicine. 1995;10(4):199–205. *https://link.springer.com/article/10.1007/BF02600255*
2. The importance of pharmacovigilance: safety monitoring of medicinal products. Geneva: World Health Organization; 2002. (*https://apps.who.int/iris/handle/10665/42493* accessed 25 March 2023).
3. Yellow Card Scheme: making medicines safer. Guidance on adverse drug reactions. London: Medicines and health care Products Regulatory Agency; 2019 (*https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/403098/Guidance_on_adverse_drug_reactions.pdf*, accessed 25 March 2023).
4. International Drug Surveillance Department. Drug safety: a shared responsibility. Edinburgh: Churchill Livingstone; 1991. (*https://onlinelibrary.wiley.com/doi/abs/10.1002/pds. 2630010210* acessed 25 March 2023).
5. A glossary of terms for community health care and services for older persons. Geneva: World Health Organization; 2004 (*https://apps.who.int/iris/bitstream/handle/10665/68896/WHO_WKC_Tech.Ser._04.2.pdf?sequence=1%20&isAllowed=y*, accessed 25 March 2023).
6. High-alert medications in community/ambulatory settings. Institute for Safe Medication Practices; 2011. (*https://www.ismp.org/sites/default/files/attachments/2017-11/highAlert-community.pdf* accessed 25 March 2023).
7. About medication errors. What is a medication error? Rockville (MD): National Coordinating Council for Medication Error Reporting and Prevention; 2019 (*http://www.nccmerp.org/about-medication-errors*, accessed 25 March 2023).
8. Medication safety in transitions of care. WHO/UHC/SDS/2019.9. Geneva: World Health Organization; 2019 (*https://www.who.int/publications/i/item/WHO-UHC-SDS-2019.9* accessed 25 March 2023).
9. Bates DW, Boyle DL, Vander Vliet MB, Schneider J, Leape L. Relationship between medication errors and adverse drug events. J Gen Intern Med. 1995;10(4):199–205. *https://www.ncbi.nlm.nih.gov/pubmed/7790981*
10. Medication review: definition approved. Zuidlaren: Pharmaceutical Care Network Europe; 2019.(*https://link.springer.com/chapter/10.1007/978-3-319-92576-9_1* accessed 25 March 2023).
11. Committee of Experts on Management of Safety and Quality in health care. Glossary of terms related to patient and medication safety. Strasbourg: Council

of Europe; 2005.(*http://www.who.int/patientsafety/highlights/COE_patient_and_medication_safety_gl.pdf* accessed 25 March 2023).

12. Vogenberg FR, Benjamin D. The medication-use process and the importance of mastering fundamentals. P T. 2011; 36(10):651-2. PMID: 22346298; PMCID: PMC3278147. *https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3278147/*
13. Conceptual framework for the international classification for patient safety. Geneva: World Health Organization; 2009 (*http://apps.who.int/iris/bitstream/handle/10665/70882/WHO_IER_PSP_2010.2_eng.pdf?sequence=1*, accessed 25 March 2023).
14. Definitions of key concepts from the WHO patient safety curriculum guide. Geneva: World Health Organization; 2012. (*https://www.who.int/publications/i/item/9789241501958* accessed 25 March 2023).

Notes

9789240058897